BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 955 174 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.11.1999 Bulletin 1999/45

(51) Int. Cl.[6]: **B41J 19/14**, B41J 2/21

(21) Application number: **98115186.3**

(22) Date of filing: **12.08.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **07.05.1998 US 74549**

(71) Applicant:
Hewlett-Packard Company
Palo Alto, CA 94303 (US)

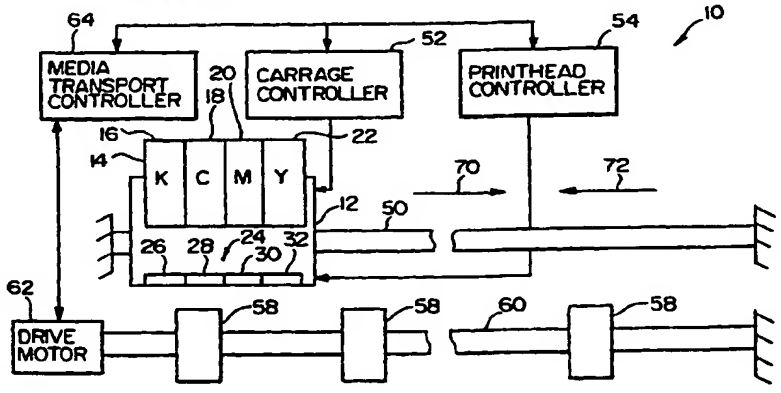
(72) Inventor: **Quintana, Jason**
Battleground, WA 98604 (US)

(74) Representative:
Liesegang, Roland, Dr.-Ing.
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)

(54) Bi-directional printing with controlled hue shifts

(57) Bi-directional color printing mode is achieved with colors applied in the same order regardless of which direction an inkjet pen is moving relative to a media sheet. For one approach a first pass of color printing onto virgin paper is performed only while the inkjet pen (14) moves in a prescribed direction (72) across the media (56). Printing a second pass then occurs while the inkjet pen moves in the opposite direction (70) across the media. The printhead prints in the same order regardless of which direction the inkjet pen moves across the media sheet.

FIG. 1



EP 0 955 174 A2

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to color inkjet printing methods and apparatus, and more particularly, to bi-directional color inkjet printing methods and apparatus.

[0002] Color printing typically involves the application of one or more base colors onto an area to give the area the appearance of a desired color. Display techniques commonly use the primary colors, red, green and blue, as the base colors. Printing techniques commonly use the secondary colors, cyan, magenta and yellow, as the base colors. Color printing with an inkjet pen involves ejecting multiple drops of the base colors onto an area to give the appearance of a desired color. Black also is used with the base colors for inkjet printing to improve the color appearance and to enable black, or gray-scale. printing. The base colors used in inkjet printing techniques are abbreviated as KCMY for convenience, where K represents black, C represents cyan, M represents magenta. and Y represents yellow.

[0003] Given conventional four-color inkjet printing, it has been observed that color hue may vary depending on the order the colors are applied to the print media. An ink dot printed in black. cyan. magenta, yellow order (KCMY) does not make the exact same color as a dot printed in YMCK order. This causes a problem when printing using bi-directional printing methods. In bi-directional printing one line is printed while the inkjet pen moves in one direction across the media sheet, and another line subsequently is printed while the inkjet pen moves in an opposite direction back across the media sheet. An advantage of bi-directional printing is that printing is faster because the pen need not move to a common reset position after each line that is printed.

[0004] It has been observed in a four pass bi-directional color inkjet printing technique that the variations in hue from line to line are small enough to be imperceptible to the common viewer. However, in two pass bi-directional color inkiet printing the variations in hue are noticeable, and generally unacceptable. Two pass bi-directional black ink printing results in acceptable print quality. Accordingly, it is common to perform four pass bi-directional color mode printing and two pass uni-directional black mode printing. Because of the ongoing desire to increase printing speed, there is a need for an inkjet method or apparatus having improved color hue control using fewer inkjet printing passes.

SUMMARY OF THE INVENTION

[0005] According to the invention, a bi-directional color printing mode is achieved in which colors are applied to a media in the same order, regardless of which direction the inkjet pen is moving relative to the media. Hue shifts are avoided. Color hues for a given desired color are the same for each line printed.

[0006] According to one aspect of the invention, an initial or first pass of color printing onto virgin paper (i.e., paper area with no ink on it) is performed only while the inkjet pen moves in a prescribed direction across the media sheet. Printing a second pass then occurs while the inkjet pen moves in the opposite direction across the media sheet. Thus, the same color order is applied during each first pass and each second pass over any given portion of the media sheet. As a result, two pass color inkjet printing is achieved without color hue shifts.

[0007] According to another aspect of the invention, an initial pass of color printing onto virgin paper is achieved by alternately feeding the paper forward and backwards along the media path between each successive print pass. In one embodiment after a first pass a minus one-half (0.5) line feed occurs for second pass printing. After the second pass, a positive one and one-half (1.5) line feed occurs for a first pass onto another virgin portion of the media sheet. The -0.5, +1.5 line feeds alternate after each printing pass assuring that the first pass printing always occurs on virgin paper, and that the second pass overlays ink from an earlier first pass.

[0008] According to an alternative approach. a color inkjet printhead has its inkjet nozzles positioned in symmetrical fashion. In a conventional color inkjet printhead. there are two rows of nozzles which eject black dots, then two rows of nozzles which eject cyan dots, then two rows of nozzles which eject magenta dots, and then two rows of nozzles which eject yellow dots. Thus the printhead prints in YMCK order while moving in one direction and KCMY direction while moving in the opposite direction. In one embodiment of a symmetrical printhead of this invention, there is one row of nozzles which ejects black dots, followed by one row of nozzles which ejects cyan dots, followed by one row of nozzles which ejects magenta dots, followed by two rows of nozzles which eject yellow dots, followed by one row of nozzles which ejects magenta dots, followed by one row of nozzles which ejects cyan dots, followed by one row of nozzles which ejects black dots. Thus, the printhead prints in the order KCMYYMCK regardless of which direction the inkjet pen moves across the media sheet.

[0009] The aspects of this invention apply to color inkjet printing devices, including desktop color inkjet printing devices, portable color inkjet printing devices and larger sized color inkjet printing devices, such as plotters. Printing devices include printers, fax machines, copiers or other ink emitting devices used in forming characters, symbols or graphics onto ink receiving media, such as paper, transparencies or cloth. An advantage of this invention is that color inkjet printing of desired quality is achieved with fewer passes, and thus at faster speeds. These and other aspects and advantages of the invention will be better understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a block diagram of a color inkjet printing apparatus for implementing a method embodiment of this invention;

Fig. 2 is a diagram of printhead layout for an embodiment of the apparatus of Fig. 1;

Fig. 3 is a block diagram of a media being fed along a print path to receive ink;

Fig. 4 is a diagram of print color order and media line feeds for respective passes of printing during a print job to a media sheet according to a conventional four-pass method of color printing;

Fig. 5 is a diagram of print color order and media line feeds for respective passes of printing during a print job to a media sheet according to a two-pass method of printing;

Fig. 6 is a diagram of print color order and media line feeds for respective passes of printing during a print job to a media sheet according to a method embodiment of this invention;

Fig. 7 is a diagram of printhead layout for an apparatus embodiment of this invention; and

Fig. 8 is a diagram of print color order and media line feeds for respective passes of printing during a print job to a media sheet according to another method embodiment of this invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Overview

[0011] Fig. 1 shows an inkjet color printing apparatus 10. In various implementations the printing apparatus 10 is part of an inkjet printer, fax machine, or copy machine. A shuttle carriage 12 carries one or more inkjet pens 14. In one embodiment there a four pens each for printing a different color. In another embodiment there is one pen for printing each of four different colors. Typically the colors are black, cyan, magenta and yellow. In other embodiments the primary colors red, green and blue may replace cyan, magenta and yellow or replace black, cyan, magenta and yellow. As shown the ink reservoirs 16-22 are in a given arrangement. At one external position is the black ink reservoir 16. Next to the black ink reservoir 16 is the cyan ink reservoir 18. Next to the cyan ink reservoir 18 is the magenta ink reservoir 20. At the opposite end, next to the magenta ink reservoir 20, is the yellow ink reservoir 22. One skilled in the art will appreciate that the specific arrangement of the reservoirs 16-22 may vary.

[0012] Fig. 2 shows a printhead 24 having four portions 26-32. Alternatively, these four portions 26-32 may represent four printheads 26-32. Each portion includes multiple rows of inkjet nozzles. All nozzles of a given portion print ink of the same color. Printhead portion 26 includes multiple rows 34 of nozzles 42 which eject black ink. Printhead portion 28 includes multiple rows 36 of nozzles 44 which eject cyan ink. Printhead portion 30 includes multiple rows 38 of nozzles 46 which eject magenta ink. Printhead portion 32 includes multiple rows 40 of nozzles 48 which eject yellow ink.

[0013] During printing, the shuttle carnage 12 moves along a rail 50 under the control of a carriage controller 52. Ink drops are ejected from the nozzles under the control of printhead controller 54. Referring to Figs. 1 and 3, a media 56 is fed along a media path by a set of rollers 58. An axle 60 for the rollers is driven by a motor 62. The motor is controlled by a media transport controller 64. For bi-directional printing, the carriage controller 52 moves the shuttle carriage 12 along the rail 50 in a first direction 70, while the printhead controller 54 causes inkjet nozzles 42-48 to fire. For an arrangement in which the printhead portion 32 for printing yellow ink is the lead portion as the carriage 12 moves across the media 56 in direction 70, ink is printed for a given row in the order yellow, magenta, cyan and black (YMCK). Once the carriage 12 advances all the way across the media 56. the media transport controller 64 moves the media 56 into position for another row of printing. The carriage controller 52 then moves the carriage 12 back across the media 56 along the rail 50 in a second direction 72, opposite the first direction 70, while the printhead controller 54 causes the inkjet nozzles 42-48 to fire again. For the arrangement as described above, the printhead portion 26 for printing black ink is in the lead position during travel in direction 72. For this return trip in the second direction 72, the ink is printed in the reverse order black, cyan, magenta and yellow (KCMY).

Printing Methods

[0014] Fig. 4 shows a diagram of the printhead 24 movement and color printing order for a conventional bi-directional four pass color printing method. After each pass, the media transport controller 64 causes the media 56 to advance by one-quarter of a line feed (+1/4 LF). During each pass in direction 70, all colors KCMY may be ejected. During each pass in direction 72. only the secondaiy colors CMY may be ejected. There are 6 passes depicted. During pass 1, the carriage 12 moves in one direction 70 and ink is applied in the order YMCK. A 0.25 line feed then occurs. During pass 2, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order CMY. A 0.25 line feed then occurs. During pass 3, the carriage 12 moves in the one direction 70 again, and ink is applied in the order YMCK. A 0.25 line feed then occurs. During pass 4, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order CMY. A 0.25 line feed then occurs. During pass 5, the carriage 12 moves in the one direction 70, and ink is applied in the order YMCK. A 0.25 line feed then occurs. During pass 6, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order CMY. A 0.25

line feed then occurs.

[0015] Note that these six print passes result in nine rows 74-90, where each row represents one-quarter of a line. This sequence repeats while printing to the entire media sheet so that four passes of color printing are achieved for each line, or more specifically for each one-quarter line. Consider the row 80 which receives ink during each of the first four passes. This row 80 receives ink in the order: YMCK, CMY, YMCK, CMY. Consider the next row 82 which receives ink during each of the second through fifth passes. This row 82 receives ink in the order: CMY, YMCK, CMY, YMCK. Row 84 receives ink in the order: YMCK, CMY, YMCK, CMY. Although the order varies for each row, it has been found that hue shifts are minimal and generally not noticeable. However, it is desirable to achieve color printing in two passes so that faster color printing speeds are achieved.

[0016] Fig. 5 shows a diagram of the printhead 24 movement and color printing order for a bi-directional two pass color printing method using a similar methodology as for the four pass method in Fig. 4. In the two pass method, a one-half line feed (+1/2 LF) occurs after each pass. During each pass in either direction 70 or 72, all colors KCMY may be ejected. There are 6 passes depicted. During pass 1, the carnage 12 moves in one direction 70 and ink is applied in the order YMCK. A 0.5 line feed then occurs. During pass 2, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order KCMY. A 0.5 line feed then occurs. During pass 3, the carriage 12 moves in the one direction 70 again, and ink is applied in the order YMCK. A 0.5 line feed then occurs. During pass 4, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order KCMY. A 0.5 line feed then occurs. During pass 5, the carriage 12 moves in the one direction 70, and ink is applied in the order YMCK. A 0.5 line feed then occurs. During pass 6, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order KCMY. A 0.5 line feed then occurs.

[0017] Note that these six print passes result in seven rows 92-104, where each row represents one-half of a line. This sequence repeats while printing to the entire media sheet so that two passes of color printing are achieved for each line, or more specifically for each one-half line. Consider the row 94 which receives ink during each of the first two passes. This row 94 receives ink in the order: YMCK, KCMY. Consider the next row 96 which receives ink during each of the second and third passes. This row 96 receives ink in the order: KCMY, YMCK. Row 98 receives ink in the order: YMCK. KCMY. Row 100 receives ink in the order: KCMY, YMCK. Row 102 receives ink in the order: YMCK, KCMY. It has been found that the hue shifts which occur due to this variation in the order which the colors are applied for each half-line are readily perceptible, and therefore result in unacceptable print quality. Accordingly, an alternative approach is needed to achieve desirable color print quality for a two pass color printing methodology.

Virgin Printing in Only One Direction

[0018] Fig. 6 shows a diagram of the printhead 24 movement and color printing order for a bi-directional two pass color printing method according to an embodiment of this invention. During each pass in either direction 70 or 72, all colors KCMY may be ejected. There are 6 passes depicted. According to one aspect of the invention, printing occurs onto a virgin area of the media 56 only while the carriage moves in the direction 72 relative to the media 56. One skilled in the art will appreciate that such printing onto the virgin area instead could occur only while the carriage 12 moves in the direction 70. By virgin area, it is meant a blank or previously unprinted area, or an area of media background (e.g., watermark, design background). To achieve such printing onto virgin areas only while printing in one direction for a two pass bi-directional printing method, a minus one-half line feed (-0.5 LF) occurs after printing in such one direction. A positive one and one-half line feed (+1.5 LF) occurs after printing in the opposite direction. One skilled in the art will appreciate that printing onto virgin paper only while printing in one direction also could be achieved for multiple pass printing of more than two passes. Different line feed motions would be used. For example, in a four pass printing mode the line feed would be minus one-quarter of a line feed (-0.50 LF) after printing in the one direction onto a virgin area, and plus three-quarters of a line feed (+1.00 LF) after printing in the other direction. Note that while printing in the one direction only one-half of the swath prints onto the virgin area.

[0019] Note that these six print passes result in seven rows 110-122, where each row represents one-half of a line. This sequence repeats while printing to the entire media sheet so that two passes of color printing are achieved for each line, or more specifically for each one-half line.

[0020] The degree of negative linefeed and positive linefeed while scanning or printing may vary for different embodiments. In differing embodiments the positive linefeed is greater than or equal to one (i.e., Pos LF $\geq$ 1.00), while the negative linefeed is less than or equal to 2 divided by the number of passes in the printing mode minus one (i.e., Neg. LF $\leq$ (2/num passes) - l)

[0021] Referring again to Fig. 6, during pass 1 the carriage 12 moves in one direction 72 and ink is applied in the order KCMY. A - 0.5 line feed then occurs. During pass 2, the carriage 12 moves in the opposite direction 70, and ink is ejected in the order YMCK. A +1.5 line feed then occurs. During pass 3, the carriage 12 moves in the one direction 72 again, and ink is applied in the order KCMY. A -0.5 line feed then occurs. During pass 4, the carriage 12 moves in the opposite direction 70, and ink is ejected in the order YMCK. A +1.5 line feed then occurs. During pass 5, the carriage 12 moves in

the one direction 72, and ink is applied in the order KCMY. A -0.5 line feed then occurs. During pass 6, the carriage 12 moves in the opposite direction 70, and ink is ejected in the order YMCK. A +1.5 line feed then occurs. Note that each row receives ink in the same order: KCMY,YMCK. This order may vary and be any prescribed order. However, the prescribed order is the same for every row printed. As a result, there are no hue shifts among the rows which can be attributed to the order the colors are applied to the media.

[0022] When commencing printing according to the method depicted in Fig. 6, half of the print swath will be blanked so as not to print during the first occurrence of printing in the direction 70 (e.g., pass 2). This corresponds to the portion in row 110. In practice such row 110 does not receive ink and is either off the media, in the media margin, or in an unprintable area of the media. Also note that the prescribed color order is a hierarchical order. For example if printing in a direction 70 occurs in the order YMCK, then for a given area of the media, yellow ink is received before magenta, cyan or black ink; magenta ink is received before cyan or black ink; and cyan ink is received before black ink. If there is not yellow for such area, then the actual order of the ink as applied is MCK. If instead there is no magenta ink for such area, then the actual order is YCK. Thus, ejecting ink in a first prescribed color order, as used herein refers to the hierarchy. One or more colors in such hierarchy may be omitted. If the hierarchy is YMCK, though, no other color would print before yellow for a given area receiving yellow ink.

Symmetrical Printhead Arrangement

[0023] Fig. 7 shows an alternate printhead 124 embodiment for the inkjet pen 14 of Fig. 1. The printhead 124 includes multiple rows of inkjet nozzles. Each row is dedicated to printing ink of a given color. The rows are arranged in symmetrical fashion according to color. The outer rows 34 print ink of the same color (e.g., black). The inner rows 36 adjacent to the rows 34 print ink of another color (e.g. cyan). The next inner rows 38 print ink of another color (e.g., magenta). The innermost rows 40 print ink of the fourth color (e.g., yellow). When the pen 14 is scanned across the media 56, the printhead 124 moves in one direction 70 or in an opposite direction 72 relative to the media 56. Because the rows in symmetrically positioned, the order in which the ink colors print is the same regardless of which direction 70, 72 that the printhead moves. For the embodiment shown, there are eight rows 34-40 with two rows for each color. The print order of the colors is KCMYYMCK when the printhead 124 moves in direction 70, and is the same when the printhead 124 moves in the opposite direction 72.

[0024] Fig. 8 depicts a two pass bi-directional color printing method in which a carriage 12 carries a pen 14 having the printhead 124. A one-half line feed (+1/2 LF) occurs after each pass. During each pass in either direction 70 or 72, all colors KCMY may be ejected. There are 4 passes depicted. During pass 1, the carriage 12 moves in one direction 70 and ink is applied in the order KCMYYMCK. A 0.5 line feed then occurs. During pass 2, the carriage 12 moves in the opposite direction 72, and ink is ejected in the same order KCMYYMCK. A 0.5 line feed then occurs. During pass 3, the carnage 12 moves in the one direction 70 again, and ink is applied in the order KCMYYMCK. A 0.5 line feed then occurs. During pass 4, the carriage 12 moves in the opposite direction 72, and ink is ejected in the order KCMYYMCK. A 0.5 line feed then occurs.

[0025] Note that these four print passes result in five rows 106-114, where each row represents one-half of a line. This sequence repeats while printing to the entire media sheet so that two passes of color printing are achieved for each line, or more specifically for each one-half line. Rows 108-112 are active rows receiving ink. Row 106 is a blank region in the margin or off the media. Each row 108-112 receives ink in the order, KCMYYMCK, during each one of two passes. The cumulative order for any such row 108-112 is KCMYYMCK, KCMYYMCK. Because the prescribed color order is the same for every row printed, there are no hue shifts which can be attributed to the order the colors are applied to the media 56.

Meritorious and Advantageous Effects

[0026] One advantage of this invention is that hue shifts are avoided among multiple lines of a print job. Color hues for a given desired color are the same for each line printed. Another advantage of this invention is that color inkjet printing of desired quality is achieved with fewer print passes. As a result faster print speeds are achievable.

[0027] Although a preferred embodiment of the invention has been illustrated and described, various alternatives, modifications and equivalents may be used. Therefore, the foregoing description should not be taken as limiting the scope of the inventions which are defined by the appended claims.

Claims

1. A method for bi-directional inkjet color printing onto a media (56), comprising the steps of:

   moving an ink drop ejection source (24) in a first direction (72) relative to the media;

   ejecting ink drops in a first prescribed color order of hierarchy (KCMY) onto a virgin area of the media while moving the ink drop ejection source in the first direction relative to the media for all printing in which the ink drop source moves in the first direction relative to the media;

moving the ink drop ejection source in a second direction (70) relative to the media; and
ejecting ink drops in a second prescribed color order or hierarchy (YMCK) while moving the ink drop ejection source in the second direction relative to the media for all printing in which the ink drop source moves in the second direction relative to the media, wherein the second direction differs from the first direction.

2. A method for bi-directional inkjet color printing onto a media (56), comprising the steps of:

moving an ink drop ejection source (124) in a first direction (72) relative to the media;
ejecting ink drops in a first prescribed color order of hierarchy (KCMY) onto the media while moving the ink drop ejection source in the first direction relative to the media;
feeding the media in one direction of either a forward direction or a backward direction relative to the ink drop ejection source after the step of ejecting in a first prescribed order;
moving the ink drop ejection source in a second direction (70) relative to the media;
ejecting ink drops in a second prescribed color order or hierarchy (YMCK) while moving the ink drop ejection source in the second direction relative to the media, wherein the second direction differs from the first direction; and
feeding the media in another direction of either the forward or the backward direction relative to the ink drop ejection source after the step of ejecting in a first prescribed order, wherein said another direction is opposite said one direction.

3. The method of claim 2, wherein ink drops are ejected onto a virgin area of the media only in the first prescribed order (KCMY).

4. The method of claim 2 or 3, wherein the step of feeding the media in one direction (72) comprises feeding the media one of either one-half a line feed or one and on-half a line feed in said one direction, and the step of feeding the media in another direction (70) comprises feeding the media the other of either said one-half a line feed or said one and one-half a line feed in said another direction.

5. The method of claim 2, 3 or 4, wherein the steps of moving in the first direction, ejecting in the first prescribed order, feeding in one direction, moving in the second direction, ejecting in the second prescribed order, and feeding in the another direction are repeated in sequence as iterations for an entire print job for the media, and wherein said one direction is the same for each iteration, and wherein said another direction is the same for each iteration.

6. The method of claim 1, 2, 3, 4 or 5, wherein the second prescribed color order differs from the first prescribed color order.

7. A color inkjet printing apparatus (10) for printing to a media (56), the apparatus comprising:

a plurality of color ink reservoirs (16-22), each reservoir storing ink of a different color;
an inkjet printhead (124) having a plurality of printing elements (42-48) arranged in a plurality of rows (34-40), each one of the plurality of rows dedicated for ejecting ink of a prescribed color, wherein there are at least two rows of the plurality of rows are dedicated to each color, and wherein the plurality of rows are symmetrically located on the printhead in terms of the color of ink ejected; and
a carriage (12) which moves the inkjet printhead in alternating first and second directions (70,72) across the media to print to the media, wherein the printhead ejects ink in a common color order of hierarchy (KCMYYMCK) regardless of whether the printhead is moving in the first direction or the second direction relative to the media.

8. A color inkjet printing apparatus (10) for printing to a media (56), the apparatus comprising:

a plurality of color ink reservoirs (16-22), each reservoir storing ink of a different color;
an inkjet printhead (24) having a plurality of printing elements (42-48) arranged in a plurality of rows (34-40), each one of the plurality of rows dedicated for ejecting ink of a prescribed color;
a carriage (12) which moves the inkjet printhead in alternating first and second directions (70,72) across the media to print to the media, causing ink to be received onto the media in a first prescribed color order of hierarchy (KCMY) while the carriage moves in the first direction (72) and ink to be received onto the media in a second prescribed color order of hierarchy (YMCK) opposite the first prescribed order while the carriage moves in the second direction (70);
drive means (62) for moving the media relative to the carriage;
means (64) for controlling the drive means to feed the media in one direction of either a forward direction or a backward direction relative to the carriage while the carriage moves in said first direction and for controlling the drive means to feed the media in another direction of the forward direction or the backward direction relative to carriage while the carriage moves in

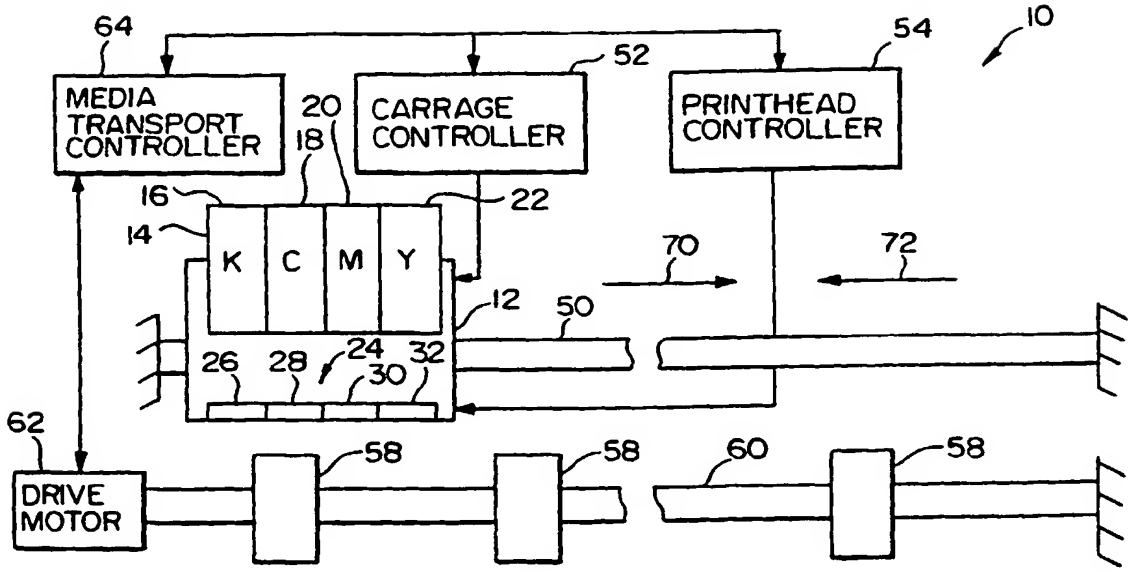
said second direction.

9. The apparatus of claim 8, wherein ink drops are ejected onto a virgin area of the media only in the first prescribed color order.

10. The apparatus of claim 8 or 9, wherein multiple pass printing with 'n' passes is performed, and wherein the control means (64) comprises:

means for controlling the drive means to feed the media at least one line feed in said one direction; and
means for controlling the drive means to feed the media at least (2/n) - 1 line feeds in said another direction; and
wherein ink drops are ejected onto a virgin area of the media during all printing to the media one of only the first prescribed color order or only the second prescribed color order.

FIG. 1



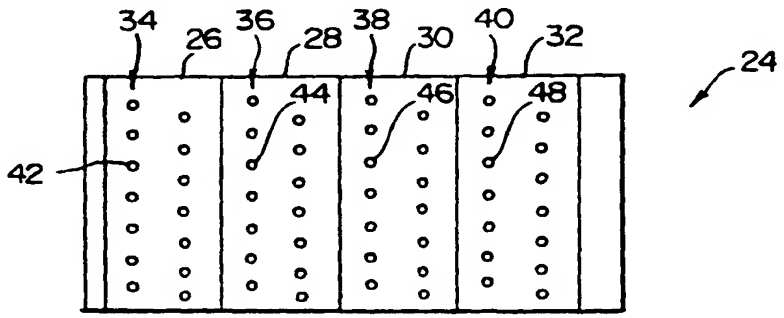


FIG. 2

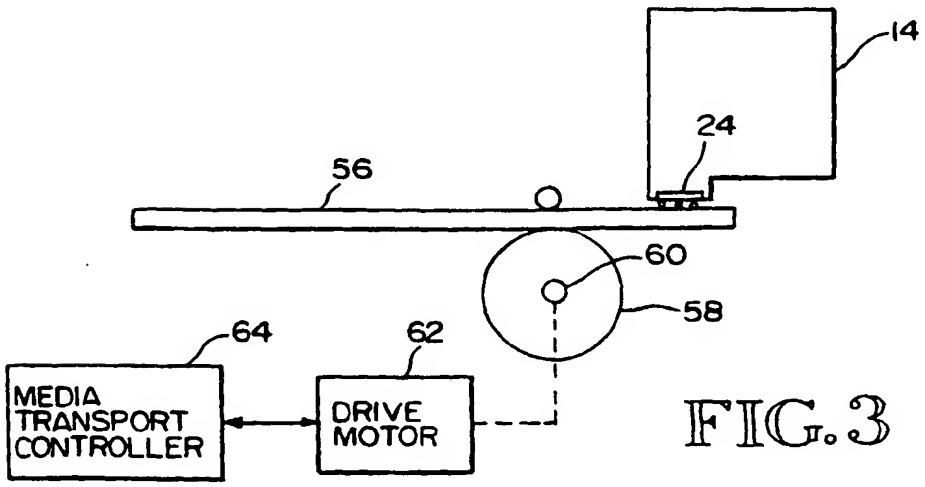


FIG. 3

FIG. 4

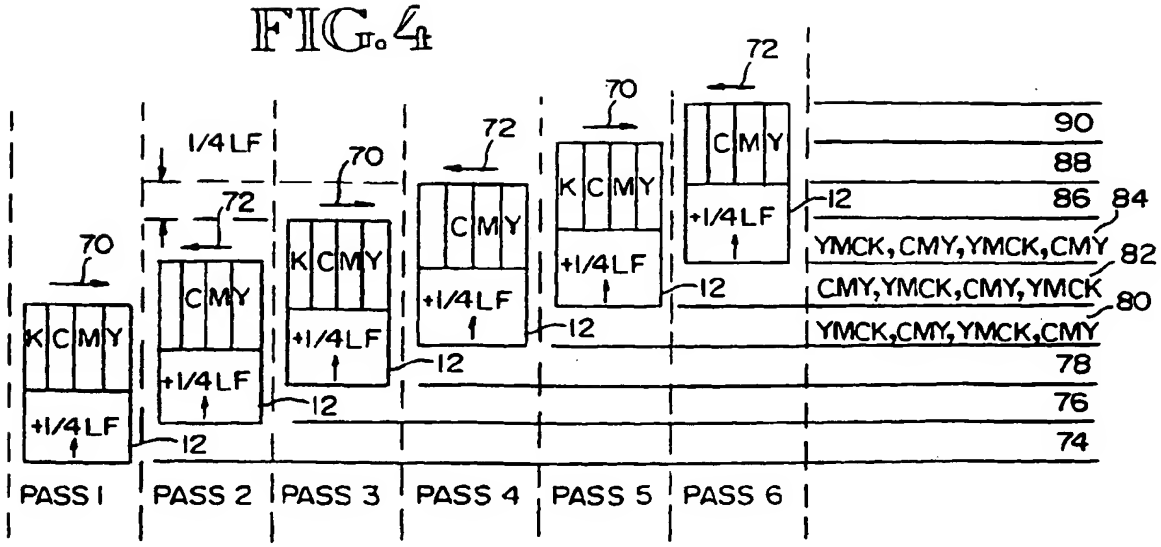


FIG. 5

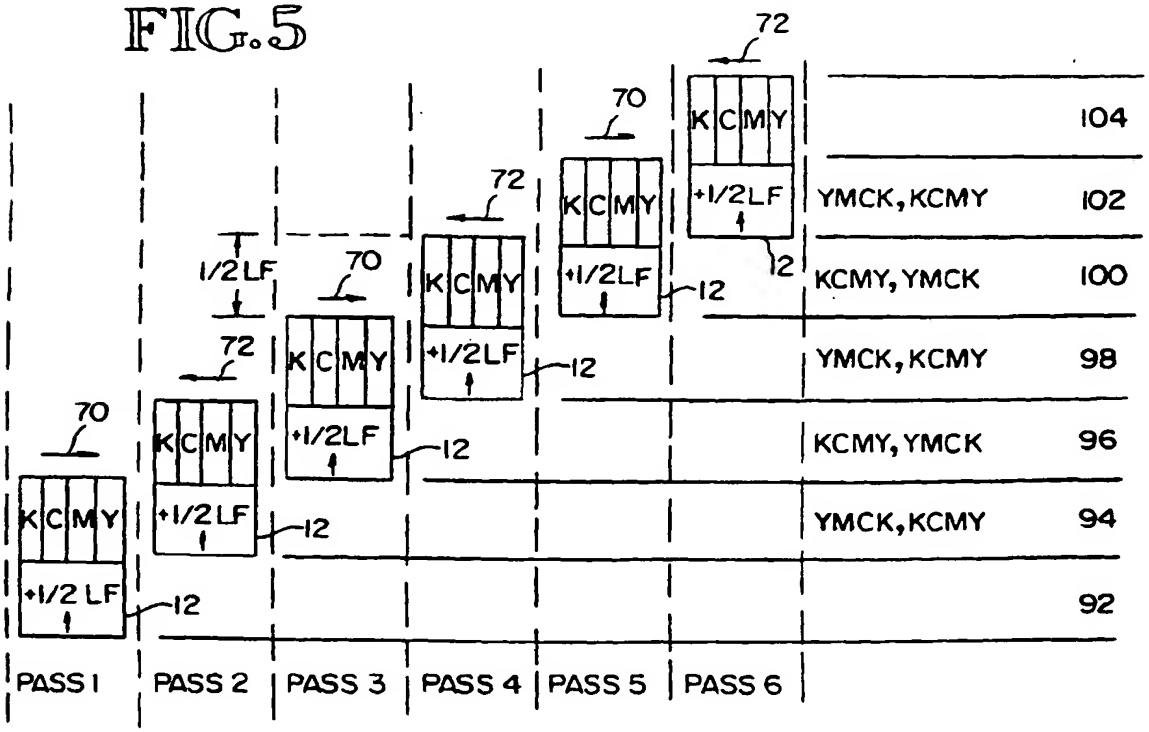


FIG.6

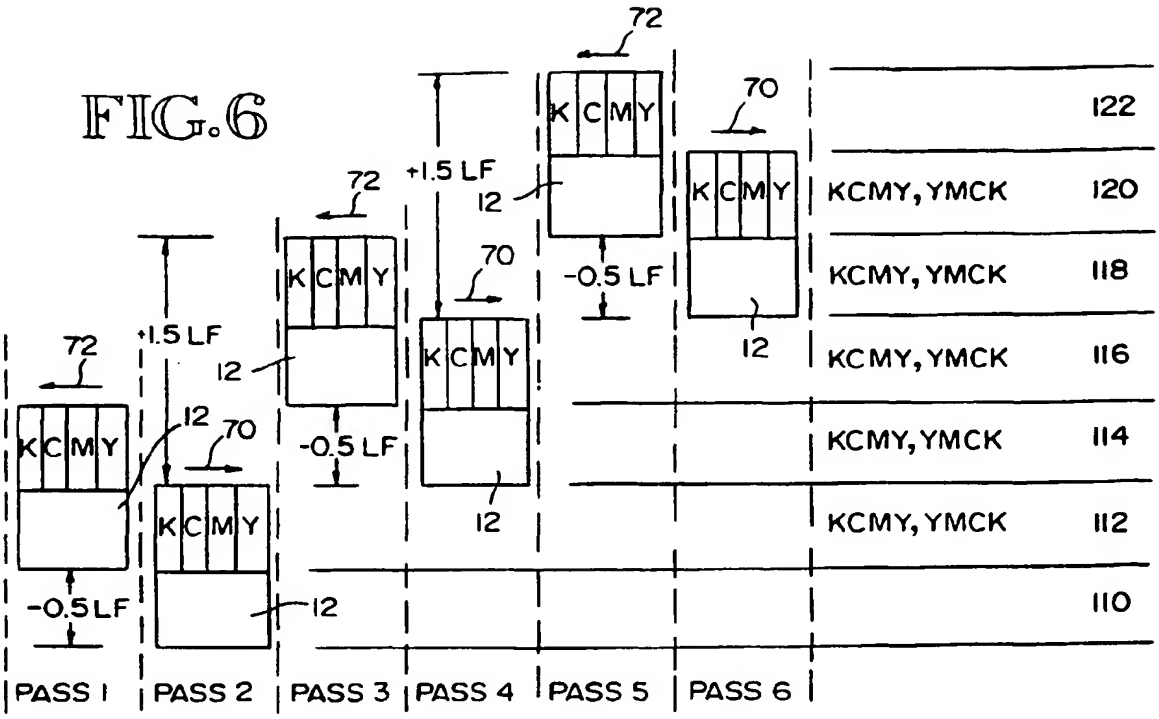


FIG.7

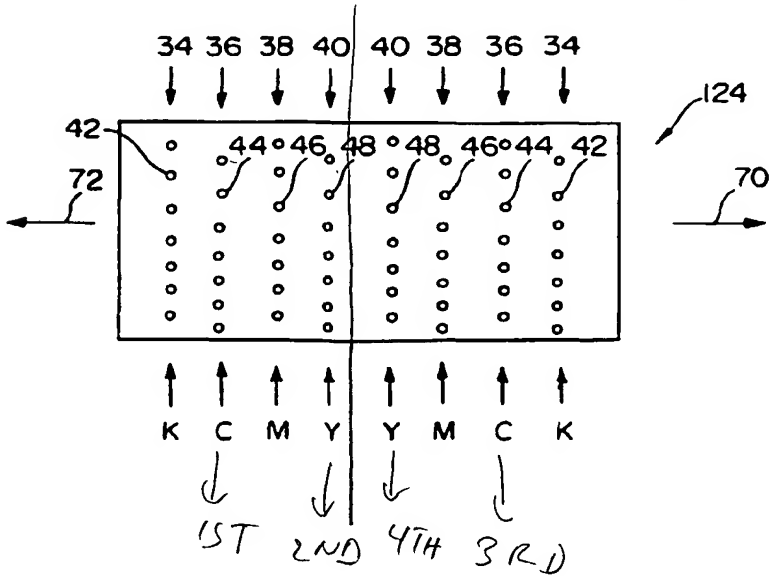
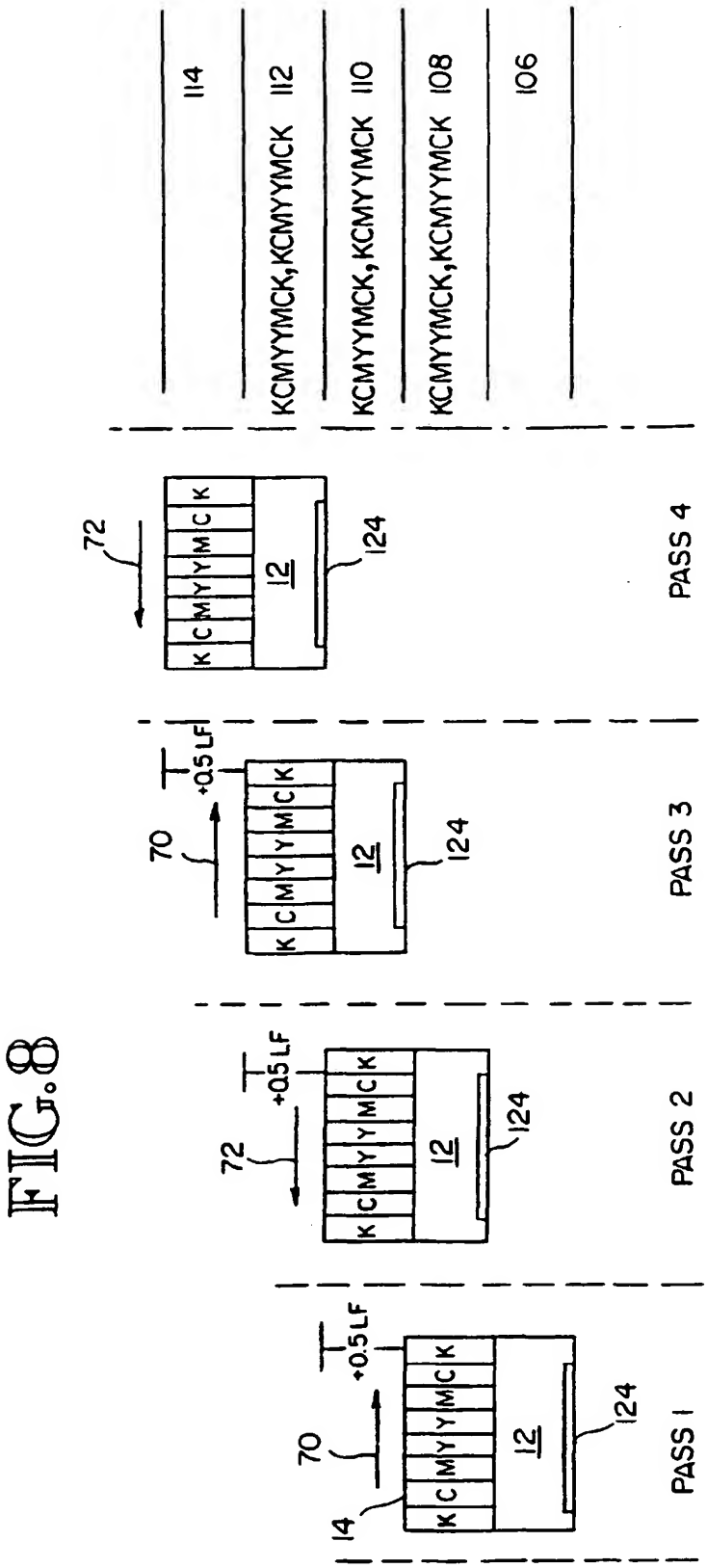


FIG. 8



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 955 174 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
24.11.1999 Bulletin 1999/47

(43) Date of publication A2:
10.11.1999 Bulletin 1999/45

(21) Application number: **98115186.3**

(22) Date of filing: **12.08.1998**

(51) Int. Cl.[6]: **B41J 19/14**, B41J 2/21

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **07.05.1998 US 74549**

(71) Applicant:
Hewlett-Packard Company
Palo Alto, CA 94303 (US)

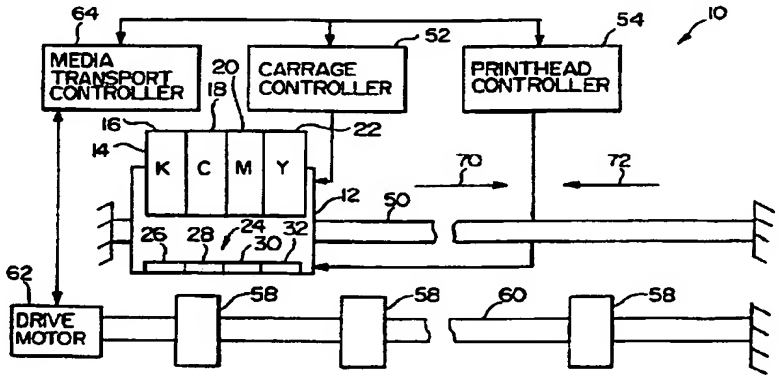
(72) Inventor: **Quintana, Jason**
Battleground, WA 98604 (US)

(74) Representative:
Liesegang, Roland, Dr.-Ing.
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)

(54) Bi-directional printing with controlled hue shifts

(57) Bi-directional color printing mode is achieved with colors applied in the same order regardless of which direction an inkjet pen is moving relative to a media sheet. For one approach a first pass of color printing onto virgin paper is performed only while the inkjet pen (14) moves in a prescribed direction (72) across the media (56). Printing a second pass then occurs while the inkjet pen moves in the opposite direction (70) across the media. The printhead prints in the same order regardless of which direction the inkjet pen moves across the media sheet.

FIG. 1



EP 0 955 174 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 11 5186

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 646 460 A (CANON KK) 5 April 1995 (1995-04-05) * page 16, line 25 - line 50; figures 5,9 * ---	1	B41J19/14 B41J2/21
A		2,7,8	
X	US 4 528 576 A (KOUMURA NOBORU ET AL) 9 July 1985 (1985-07-09) * the whole document * ---	1	
A		7	
A	US 4 207 579 A (MARINOFF GEORGE ET AL) 10 June 1980 (1980-06-10) * column 2, line 7 - line 9 * * column 2, line 50 - column 3, line 3 * * column 4, line 10 - line 31 * ---	2,8	
A	EP 0 661 870 A (XEROX CORP) 5 July 1995 (1995-07-05) * page 4, column 5, line 11 - column 6, line 46; figure 2 * ---	1,2,7,8	
A	EP 0 610 096 A (CANON KK) 10 August 1994 (1994-08-10) * column 8, line 9 - column 10, line 49; figures 5-7 * ---	1,2,7,8	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41J
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. - , 26 December 1995 (1995-12-26) & JP 07 195715 A (KATSURAGAWA ELECTRIC CO LTD), 1 August 1995 (1995-08-01) * abstract * --- -/--	1,7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 September 1999	De Groot, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 11 5186

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 199, no. 703, 31 March 1997 (1997-03-31) & JP 08 295034 A (CANON INC.), 12 November 1996 (1996-11-12) * abstract *	1,7	
A	PATENT ABSTRACTS OF JAPAN vol. 015, no. 186 (M-1112), 14 May 1991 (1991-05-14) & JP 03 045351 A (MATSUSHITA ELECTRIC IND CO LTD), 26 February 1991 (1991-02-26) * abstract *	1,7	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 209 (M-0968), 27 April 1990 (1990-04-27) & JP 02 047075 A (MINOLTA CAMERA CO LTD), 16 February 1990 (1990-02-16) * abstract *	1,7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 September 1999	De Groot, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 11 5186

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-09-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0646460 A	05-04-1995	JP 7101052 A	18-04-1995
		JP 8039793 A	13-02-1996
US 4528576 A	09-07-1985	JP 1706581 C	27-10-1992
		JP 3076223 B	04-12-1991
		JP 58179652 A	20-10-1983
		JP 1707659 C	27-10-1992
		JP 3077066 B	09-12-1991
		JP 58179653 A	20-10-1983
		JP 1706582 C	27-10-1992
		JP 3076224 B	04-12-1991
		JP 58179655 A	20-10-1983
		JP 1706583 C	27-10-1992
		JP 3076225 B	04-12-1991
		JP 58179656 A	20-10-1983
US 4207579 A	10-06-1980	CA 1129478 A	10-08-1982
		DE 3000466 A	24-07-1980
		FR 2445766 A	01-08-1980
		GB 2040818 A,B	03-09-1980
		IT 1129051 B	04-06-1986
		JP 55111264 A	27-08-1980
		NL 7908927 A	10-07-1980
EP 0661870 A	05-07-1995	JP 7214797 A	15-08-1995
EP 0610096 A	10-08-1994	JP 6226998 A	16-08-1994
		JP 6312517 A	08-11-1994
JP 07195715 A	01-08-1995	NONE	
JP 08295034 A	12-11-1996	NONE	
JP 03045351 A	26-02-1991	NONE	
JP 02047075 A	16-02-1990	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82